(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 758 803 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.02.1997 Bulletin 1997/08

(51) Int Cl.[6]: **H01Q 17/00**, H05K 9/00

(21) Application number: 96305952.2

(22) Date of filing: 14.08.1996

(84) Designated Contracting States:
DE ES FR GB IT SE

(30) Priority: 16.08.1995 GB 9516792

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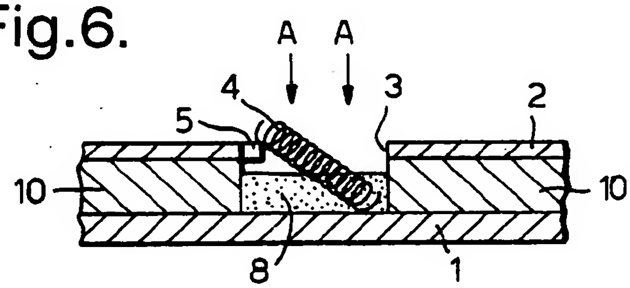
(54) **Fabrication of chiral composite material**

(57) Chiral composite material is made using an apertured plate (2) having apertures (3) therethrough corresponding to the desired location of Chiral elements (4) in the composite material. The plate (2) is located to overlie a substrate (1) with or without the intermission of spacer (10) which may be apertured in correspondence with the plate (2) or which may be ring like in form. The Chiral elements (4) are held in position by locating means such as a tab (5) which may be magnetic in, on or associated with the plate (2) and a first layer (8) of liquid host material is placed in the apertures (3) around the elemtns (4) against the substrate (1), allowed to set and the plate (2) removed. A second layer (9) of liquid host material is then applied to the set first layer (8) and allowed to set to produce the desired composite material.

Fig.6.



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Description

This invention relates to the fabrication of Chiral composite material and particular, but not exclusively, to a method for the fabrication of such material and to Chiral composite material produced by this method.

Chiral, that is handed, elements are useful for absorbing electro magnetic radiation, for example as radar absorbent material, particularly when embedded in or loaded into host materials such as a resin to form a composite material. However attempts to manufacture such composite materials have encountered difficulties due to the small size of the Chiral elements, usually helices, and the relatively large number of such Chiral elements required.

For these reasons location of the Chiral elements within the composite material is difficult, particularly as it is undesirable for the elements to be in contact with one another and is desirable for the elements to be distributed uniformly within the composite material. If the Chiral elements are not uniformly distributed the electro magnetic performance of the resulting composite material may be affected adversely. Additionally the orientation of the Chiral elements within the composite material has an influence on the electro magnetic properties of the material so that it may be necessary to fabricate a composite material with either randomly orientated elements or elements aligned in a specific directions.

There is thus a need for a generally improved method for the fabrication of Chiral composite material which at least minimises the foregoing difficulties.

According to the present invention there is provided a method for the fabrication of Chiral composite material, characterised by the steps of preparing an apertured plate having apertures therethrough corresponding to the desired location of Chiral elements in the composite material to be prepared, locating the plate to overlie a substrate, placing the Chiral elements in the apertures at the desired angle and orientation to the substrate and holding them in position by locating means in, on or associated with the apertured plate , placing a first layer of liquid host material in the apertures in the plate around the Chiral elements and against the substrate and allowing the first layer to set, removing the apertured plate and applying a second layer of liquid host material to the set first layer and in turn allowing the second layer to set to produce the desired composite material.

Preferably the aperture plate utilised is made from silicon.

Conveniently the or each locating means comprises a tab projecting into the relevant aperture in the plate.

Advantageously the tab is provided with a recessed surface to form a hook on which a projecting end or part of the associated Chiral element is engaged.

Preferably the tab is dimensioned to project into a region of the associated Chiral element which rests there against.

Conveniently the apertured plate utilised is magnetic, the Chiral elements utilised are magnetic and in which the magnetic attraction between the apertured plate and Chiral elements provides the locating means.

Advantageously the thickness of the apertured plate is chosen to provide the required thickness of the first layer around the Chiral elements.

Alternatively the required thickness of the first layer is obtained by means of a spacer of desired thickness between the apertured plate and substrate.

Preferably the spacer utilised is a plate of the same or different material to that of the first layer, provided with apertures therethrough corresponding to the apertures in the apertured plate and in register therewith, said apertured spacer plate being incorporated in said set first layer.

Alternatively, the spacer utilised is in the form of a ring of any desired shape locatable between the apertured plate and substrate to extend in the vicinity of an outer edge of the apertured plate, to form an outer boundary for the first layer and removable therefrom when the first layer has set.

Preferably the thickness of the apertured plate or of the spacer is chosen to provide the desired angle and orientation of the Chiral elements in the composite material.

Conveniently the Chiral elements utilised are helices, Mobius bands or irregular tetrahedra in shape.

Advantageously the Chiral elements utilised are metallic or plastics.

Preferably the substrate is planar or has a surface provided with depressions therein to complement the apertures in the overlying apertured plate and provide additional means for receiving and locating the Chiral elements therein.

Conveniently the depth of the depressions in the substrate is chosen to assist in providing the desired angle of the Chiral elements with respect to the substrate.

Advantageously the first and/or second layer material utilised is/are a resin or polystyrene.

Advantageously the method is carried out at least twice to provide a Chiral composite material with a plurality of Chiral element layers.

For a better understanding of the present invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which;

Fig. 1 is a diagrammatic sectional view through a substrate and apertured plate according to one step in the method of the present invention,

Fig. 2 is a diagrammatic sectional view of a substrate, apertured plate and spacer according to an alternative step in the method of the present invention,

Fig. 3 is a diagrammatic cross sectional view of a substrate, spacer and apertured plate according to yet another alternative step in the method of the present invention,

Fig. 4 is a plan view from above of Fig. 3,
Fig. 5 is a perspective view to an enlarged scale of a tab for use in the method of the present invention,
Fig. 6 is a diagrammatic cross sectional view of a substrate, spacer and apertured plate according to a second step in the method of the present invention,
Fig. 7 is a cross sectional view of a substrate and spacer according to a third step in the method of the present invention, and
Fig. 8 is a diagrammatic cross sectional view through part of a modified way of implementing the method according to the present invention,

A method according to the present invention for the fabrication of Chiral composite material basically employs a substrate 1 which is preferably planar in form as shown in Figures 1 to 7 and conveniently made of silicon. Also utilised is a an apertured plate 2 which has a plurality of apertures 3 there through corresponding to the desired location of Chiral elements 4 in the composite material to be prepared.

The apertured plate 2 which can be made of any desired material such as metal or silicon, is located to overlie the substrate 1 and the Chiral elements 4 are placed in the apertures 3 at the desired angle and orientation to the substrate 1 and held in position by locating means 5 in, on or associated with the apertured plate 2. The or each locating means 5 preferably is a tab, as shown in Fig. 5, projecting into the relevant aperture in the plate as shown in Figures 1 to 6 and 8 of the accompanying drawings. The tab 5 may be provided with a recessed surface 6 as shown in Fig. 5 of the accompanying drawings to form a hook 7 on which a projecting end or part of the associated Chiral element is engaged as shown for example in Figures 1, 2, 3 and 4. Alternatively the tab 5 is dimensioned to project into a region of the associated Chiral element 4 which rests there against so that the tab projects into the element which preferably is a helix as shown in Fig. 6.

As a further alternative the positioning plate 2 utilised is magnetic, preferably made of metal, and the Chiral elements 4 are magnetic so that the magnetic attraction between the plate 2 and Chiral elements 4 provides the locating means. Conveniently this is still by way of a tab 5 projecting into the aperture 3 as shown, for example, in Fig. 8 of the accompanying drawings.

Following location of the Chiral elements 4 a first layer 8 of liquid host material such as a resin or polystyrene is applied in the direction of the arrows A in Fig .6 into the apertures 3 in the apertured plate 2 to at least partially surround the Chiral elements 4. The liquid material of the first layer flows around the Chiral elements 4 and against the substrate 8 and is allowed to set. Subsequently the apertured plate 2 is removed and a second layer 9 of liquid host material which again may be a resin or a polystyrene is applied to the set first layer 8 as shown in Fig. 7 and in turn allowed to set to produce the desired composite material.

The angle Θ, as shown in Fig. 1, between the Chiral element 4, conveniently a helix, is determined primarily by the distance between the substrate 1 and the apertured plate 2 upper surface. This maybe achieved by appropriately dimensioning the thickness of the apertured plate 2 as shown in Fig. 1 which may also control the thickness of the first layer 8 of host material around the element 4. Alternatively the thickness of the first layer and angle of inclination Θ of the Chiral element 4 to the substrate 1 maybe obtained by means of a spacer 10 of desired thickness between the apertured plate 2 and substrate 1.

In the examples shown in Figures 2 and 8 of the accompanying drawings the spacer 10 is in the form of a ring of any desired shape locatable between the apertured plate 2 and the substrate 1 to extend in the vicinity of an outer edge of the apertured plate 2 to form an outer boundary for the first layer 8 of host material and removable therefrom when the first layer 8 has set. Alternatively, as shown in Figures 3, 6, and 7 the spacer 10 utilised is a plate of the same or different material to that of the first layer 8 provided with apertures 11 therethrough corresponding to the apertures 3 in the positioning plate 2 and in registered therewith.

The apertured spacer plate 10, as shown in Fig. 7, may be incorporated in the set first layer 8 of host material and in the set second layer 9 of host material. Thus in the method the invention the thickness of the apertured plate 2 alone or together with the thickness of the spacer 10 when used therewith is such as to provide the desired angle of inclination feature and orientation of the Chiral elements 4 with respect to the substrate 1 in the composite material. As aforesaid these Chiral elements 4 may be helices, Mobius bands or irregular tetrahedra in shape. They may be made of metallic material or of plastics material.

Although the first layer 8 and second layer 9 of host material have been shown as insertable via the apertures 3 and apertures 11 they may alternatively be inserted via holes provided laterally through the spacer 10. The method can be carried out at least twice to provide a Chiral composite material with a plurality of Chiral element layers or alternatively the single layer Chiral element composite material may be produced according to the method of the invention and a plurality of these combined to produce either thicker or larger structures.

In order to obtain an isotropic Chiral composite material or a material with a predetermined angular dispersion of Chiral elements 4 the substrate la as shown in Fig. 8 may be provided with depressions 12 therein to complement the apertures 3 in the overlying apertured plate 2 and provide additional means for receiving and locating the Chiral elements 4 therein. The depth of the depressions 12 is chosen to vary the angle of inclination Θ of the Chiral elements 4 to the base plate 1a.

Claims

1. A method for the fabrication of Chiral composite material, characterised by the steps of preparing an apertured plate (3) having apertures (3) therethrough corresponding to the desired location of Chiral elements (4) in the composite material to be prepared, locating the plate (2) to overlie a substrate (1), placing the Chiral elements (4) in the apertures (3) at the desired angle and orientation to the substrate (1) and holding them in position by locating means (5, 6, 7) in, on or associated with the apertured plate (2), placing a first layer (8) of liquid host material in the apertures (3) in the plate (2) around the Chiral elements (4) and against the substrate (1) and allowing the first layer (8) to set, removing the apertured plate (2) and applying a second layer (9) of liquid host material to the set first layer (8) and in turn allowing the second layer (9) to set to produce the desired composite material.

2. Method according to Claim 1, in which the apertured plate (2) utilised is made from silicon.

3. Method according to Claim 1 or Claim 2, in which the or each locating means comprises a tab (5) projecting into the relevant aperture (3) in the plate (2).

4. Method according to Claim 3, in which the tab (5) is provided with a recessed surface (6) to provide a hook (7) on which a projecting end or part of the associated Chiral element (4) is engaged.

5. Method according to Claim 3, in which the tab (5) is dimensioned to project into a region of the associated Chiral element (4) which rests there against.

6. Method according to Claim 1, in which the apertured plate (2) utilised is magnetic, the Chiral elements (4) utilised are magnetic and in which the magnetic attraction between the apertured plate (2) and Chiral elements (4) provides the locating means.

7. Method according to any one of Claims 1 to 6, in which the thickness of the apertured plate (2) is chosen to provide the required thickness of the first layer (8) around the Chiral elements (4).

8. Method according to any one of Claims 1 to 6, in which the required thickness of the first layer (8) is obtained by means of a spacer (10) of desired thickness between the apertured plate (2) and substrate (1).

9. Method according to Claim 8, in which the spacer (10) utilised is a plate of the same or different material to that of the first layer (8), provided with apertures (11) therethrough corresponding to the apertures (3) in the apertured plate (2) and in register therewith, said apertured spacer plate (10) being incorporated in said set first layer (8).

10. Method according to Claim 8, in which the spacer (10) utilised is in the form of a ring of any desired shape locatable between the apertured plate (2) and substrate (1) to extend in the vicinity of an outer edge of the apertured plate, to form an outer boundary for the first layer (8) and removable therefrom when the first layer (8) has set.

11. Method according to Claim 1 or Claim 8, in which the thickness of the apertured plate (2) or of the spacer (10) is chosen to provide the desired angle and orientation of the Chiral elements (4) in the composite material.

12. Method according to any one of Claims 1 to 11, in which the Chiral elements (4) utilised are helices, Mobius bands or irregular tetrahedra in shape.

13. Method according to Claim 12, in which the Chiral elements (4) utilised are metallic or plastics.

14. Method according to any one of claims 1 to 13, in which the substrate (1) is planar or has a surface provided with depressions (12) therein to complement the apertures (3) in the overlying apertured plate (2) and provide additional means for receiving and locating the Chiral elements (4) therein.

15. Method according to Claim 14, in which the depth of the depressions (12) in the substrate (1) is chosen to assist in providing the desired angle of the Chiral elements (4) with respect to the substrate (1).

16. Method according to any one of Claims 1 to 15, in which the first and/or second layer material utilised is/are a resin or polystyrene.

17. Method according to any one of Claims 1 to 16, carried out at least twice to provide a Chiral composite material with a plurality of Chiral element layers (4).

Fig.1.

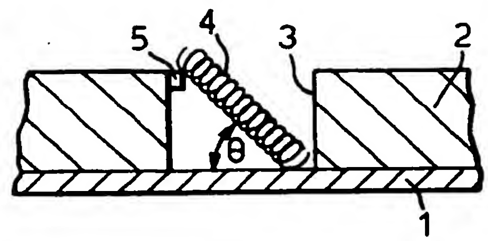


Fig.2.

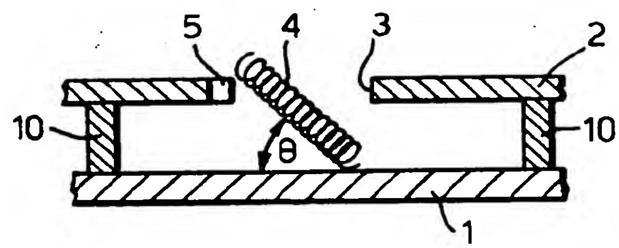


Fig.3.

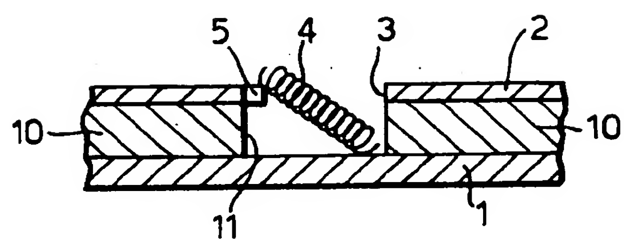


Fig.4.

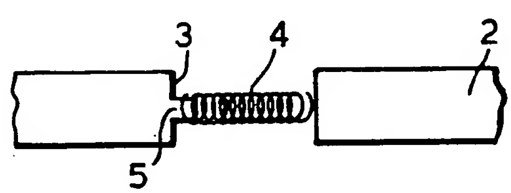


Fig.5.

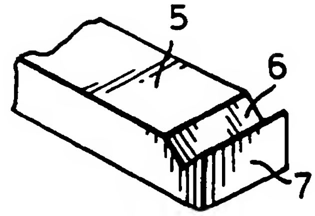


Fig.6.

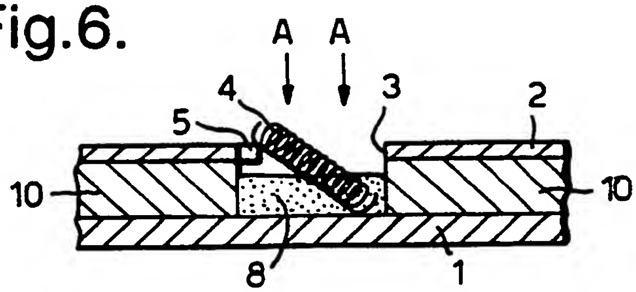


Fig.7.

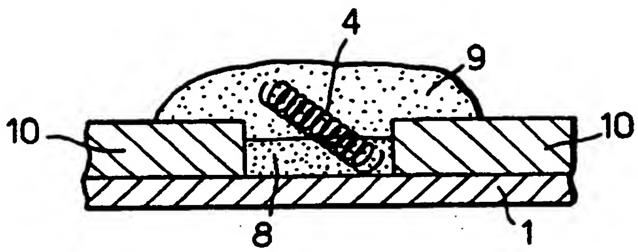
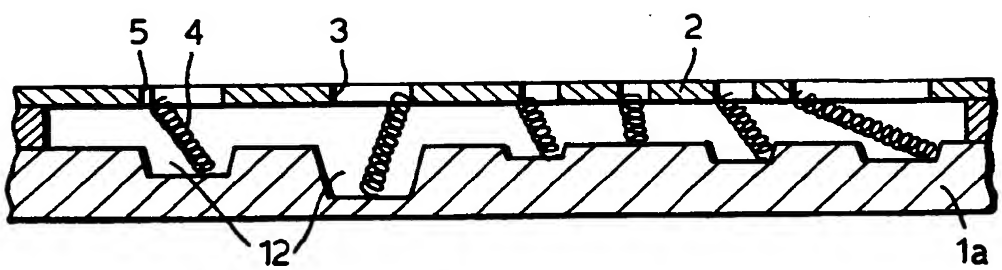


Fig.8.



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 5952

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP-A-0 520 677 (GRACE NV) 30 December 1992 * page 3, line 15 - page 4, line 40; figures 1-11B * ---	1-17	H01Q17/00 H05K9/00
A	FR-A-2 678 470 (COMMISSARIAT ENERGIE ATOMIQUE ;UNIV PARIS CURIE (FR)) 31 December 1992 * page 10, line 8 - page 12, line 16; figures 5A-5E * ---	1-17	
A	WO-A-92 12549 (UNIV PENNSYLVANIA) 23 July 1992 * claims 1-12; figures 1,9-10C * ---	1	
A	WO-A-90 03102 (UNIV PENNSYLVANIA) 22 March 1990 * claims 1-24; figures 1-4 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			H01Q H05K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 November 1996	Angrabeit, F

CATEGORY OF CITED DOCUMENTS

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